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Ralph V. Chamberlin

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19 ABSTRACT (Continue on reverse if necessary and identify by block number)

Annual progress report of research on the dynamics of fractal systems. Accomplishments include construction, and initial testing, of a high-frequency susceptometer and SQUID magnetometer, capable of measurements from 0.01-100 Mhz, and 10^{-5}-10^{5} seconds. Preliminary investigations of 11.9% Au:Fe indicate the presence of large, strongly coupled, ferromagnetic domains which obey a stretched-exponential relaxation with a time constant $\tau \sim 10^{17}$ s. Future experiments and collaborations are discussed.

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DATE: 11 June 1988

PROGRESS REPORT ON CONTRACT N00014-88-K-0094

PRINCIPAL INVESTIGATOR: Dr. Ralph V. Chamberlin

CONTRACTOR: Arizona State University

CONTRACT TITLE: Fracton Dynamics on Fractal Networks

START DATE: 1 November 1987

RESEARCH OBJECTIVE: Investigate the dynamical behavior of various tenuously connected systems, with particular emphasis on characterizing the relaxation of fracton excitations on fractal networks.

PROGRESS (Year 1): Since last November, when the ONR funding was initiated, we have constructed a high-frequency susceptometer and a SQUID magnetometer specifically designed for magnetic relaxation measurements. These instruments have been used to measure susceptibilities from 0.1-10 Mhz, and magnetizations from 10^{-3} to 10^{3} s. Preliminary high-frequency susceptibility measurements on a 11.9% Au:Fe sample show a spontaneous alignment of spins at $T_C \approx 100$ K, but even at $T/T_C = 0.1$, the magnetization obeys a stretched-exponential relaxation: $M = M_0 \exp[-(t/\tau)^{1-n}]$. Although the time constant is astronomical ($\tau \sim 10^{17}$ s), the sensitivity of the magnetometer is sufficient to unequivocally establish relaxation, with $n = 0.90 \pm 0.01$, from $\sim 10^{-3}$ to $\sim 10^{3}$ s. These measurements indicate the presence of large ferromagnetic domains which are strongly coupled, but which will eventually (on the time scale of the universe!) become randomly oriented.

WORK PLAN (Year 2): We are currently implementing design modifications which should extend the capabilities of our instruments to:

	SUSCEPTOMETER	MAGNETOMETER
TEMPERATURE:	2-300 K	0.5-100 K
SENSITIVITY:	10^{-4} emu	10^{-8} emu
FIELD:	1 Oe	0.01-1000 Oe
RESPONSE:	0.01-100 Mhz	10^{-5}-10^{5} s

We plan to continue our investigation of Au:Fe to thoroughly characterize the dynamic response of a randomly-dilute magnetic system. We will focus on samples near the percolation concentration (11.9%?), and near the spin-glass/ferromagnetic transition temperature, where the fractal coherence length, and spin-spin correlation length diverge. This should extend the fracton regime into the SQUID response range, providing a direct measure of fractal dynamics. Our investigation will continue by studying additional fractal systems, including fractally confined antiferromagnets and fractally connected superconducting networks.

We also plan to initiate a collaboration with Prof. Ray Orbach, from UCLA, to study spin-glass dynamics over the extended time range we have available.

PUBLICATIONS AND REPORTS (Year 1):

Preprints describing the novel susceptometer and magnetometer may be available by October 1, 1988.

An annual report will be distributed to the ONR Distribution List as required.

TRAINING ACTIVITIES: A master's degree candidate, Mr. John O'Farrell, has gained considerable experience with high frequency measurements in constructing the susceptometer. Dr. Donald Haines (a post-doctoral fellow at Montana State University with experience using SQUID magnetometers for dynamic measurements) will be joining our group in September.

Women or minorities-0
Non-citizens -0

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